DEFLECTOR OF A MICRO-COLUMN ELECTRON BEAM APPARATUS AND METHOD FOR FABRICATING THE SAME

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a deflector positioned between electron beam lens in a micro-column electron beam apparatus used for exposure process for patterning a photoresist film, and more specifically to a deflector having a plurality of deflecting plates correspondingly arranged at the upper and lower sides thereof and method for fabricating the same.

2. Description of the Prior Art

In general, a micro-column electron beam apparatus is used in an exposure process for patterning a photoresist film. In the micro-column electron beam apparatus, the photoresist film is exposed to a designed form by electron beam emitted from a cathode. The micro-column electron beam apparatus consists of electron beam lens through which the electron beam passes, and a deflector that electrically controls direction of the electron beam and positioned between the electron beam lenses. The micro-column electron beam apparatus receives data of a designed form from a pattern generator, and irradiates the electron beam to a photoresist film formed on a mask or wafer with a direction commanded by the data. Thereby, the photoresist film is exposed to the designed form.

The deflector has pairs of 2 ~ 16 deflecting plates arranged opposite to each other at the upper and lower sides of the deflector. The deflecting plates control the path of the electron beam in accordance with the data supplied from the pattern generator.

In fabrication process of the deflector, the deflecting plates are made by a wet etching or Deep RIE (reactive ion etch) process of a silicon wafer having a thickness of 0.2mm to 1mm, and anodic bonded on both sides of a base isolation plate consisted of Pyrex Glass, etc. However, as this conventional method has to make deflecting plates and fix them on both sides of the base isolation plate, alignment and uniformity between the deflecting plates cannot be easily improved, and reproducibility and structural durability cannot also be improved.

SUMMARY OF THE INVENTION

It is therefore an object of the present invention is to provide a deflector of a micro-column electron beam apparatus capable of eliminating above mentioned disadvantages by forming simultaneously plurality of deflecting plates at the upper and lower sides of the base isolation plate though metal plating process, and method for fabricating the same.

To achieve the above object, the deflector of a micro-column electron beam apparatus in accordance with the present invention comprises an isolation substrate having a hole formed at center of the isolation substrate; plurality of deflecting plates formed along circumference of the hole at upper and lower sides of the isolation substrate; plurality of pads formed on edges of the upper and lower sides of the isolation substrate; and plurality of wirings for connecting each

of the deflecting plates and each of the pads, wherein the deflecting plates, wirings, and pads are formed integrated.

A hole through which electron beams pass is formed within the hole by arrangement of deflecting plates, and the deflecting plates are arranged opposite to each other with the isolation substrate.

The isolation substrate is made of ceramic alumina, and the deflecting plates, wirings, and pads are made of beryllium, phosphor bronze, bronze, cupro-nickel, stainless steel, or nickel, and formed by plating process.

In addition, a method for fabricating a deflector of a micro-column electron beam apparatus in accordance with the present invention comprises a step of burying and hardening polymer in a hole formed at center of a substrate; a step of forming first mask pattern so that some portion of seed metal layers is exposed to form deflecting plates, wirings and pads after forming the seed metal layers on both surfaces of the substrate; a step of forming first metal layers on the exposed portion of the seed metal layers; a step of forming second mask pattern on both surfaces of the substrate to expose the first metal layers in which the deflecting plates are to be formed; a step of forming second metal layers on the exposed portion of the first metal layers; a step of removing the first and second mask patterns; and a step of removing the seed metal layers exposed and polymers buried in the hole.

The first mask pattern is a photoresist film, and formed by coating or laminating process, and the first and second metal layers are made of beryllium, phosphor bronze, bronze, cupro-nickel, stainless steel, or nickel, and formed by plating process.

The second mask pattern consists of polymers, and formed by laminating process.

The step for removing polymers buried in the hole further comprises a step for plating metal on exposed surfaces of the first and second metal layers.

Although the present invention has been described in conjunction with the preferred embodiment, the present invention is not limited to the embodiments, and it will be apparent to those skilled in the art that the present invention can be modified in variation within the scope of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

The above and other objects, effects, features and advantages of the present invention will become more apparent by describing in detail the preferred embodiment of the present invention with reference to the attached drawings in which:

Fig. 1 shows a plane view for explaining a deflector of a micro-column electron beam apparatus in accordance with an embodiment of the present invention;

Fig. 2 shows a cross sectional view taken along the A1 – A2 line of Fig. 1;

Fig. 3 shows a perspective view for explaining a deflector of a micro-column electron beam apparatus in accordance with an embodiment of the present invention;

Fig. 4 shows a cross sectional view taken along the line B1 – B2 of Fig. 3;

Fig. 5A to 5M show cross sectional views for explaining method for fabricating the deflector of the micro-column electron beam apparatus in accordance with the present invention;

Fig. 6 shows a plane view of a mask for explaining Fig. 5E; and

Fig. 7 shows a plane view of a mask for explaining Fig 5H.

Similar reference characters refer to similar parts in the several views of the drawings.

DESCRIPTION OF THE PREPERRED EMBODIMENT

Silicon is used as a conductive material and Pyrex is used as a base isolation plate in prior art. However, metals such as beryllium, phosphor bronze, stain, nickel etc. are used as the conductive material in the present invention, and ceramic alumina as the base isolation plate, and deflecting plates of conductive materials are fabricated using plating process. Bronze is used as a representative metal for explaining the present invention, however, it should be understand that any metal that confirm to the purpose of the present invention can be used.

Hereinafter, embodiments of the present invention will be explained with reference to the accompanying drawings. In an embodiment of the present invention, eight deflecting plates called octapole are formed on the upper and lower sides of the deflector, respectively, and the eight deflecting plates are opposite to each other.

The deflector of the micro-column electron beam apparatus in accordance with the present invention, for example, consists of an isolation substrate **1** in

which a hole **2** with 2mm to 3mm caliber is formed in the center of the isolation substrate **1**, and eight deflecting plates **3** formed on upper and lower sides of the isolation substrate **1**, respectively, and arranged along the circumference of the hole **2** as shown in Fig. 1. Upper deflecting plates **3a** and lower deflecting plates **3b** are arranged opposite to each other with the isolation substrate **1** as shown in Fig. 2, a hole **4** with 500 μm to 1mm caliber is formed through which electron beams pass within the hole **2** by the arrangement of the deflecting plates **3**. In addition, pads **6** are formed at both edges of the isolation substrate **1**, and connected to each of the deflecting plates **3** through wirings **5**.

Fig. 3 shows a perspective view for explaining the deflector as shown in Fig. 1, and Fig. 4 shows a cross sectional view taken along the line B1 – B2 of Fig. 3.

A method for fabricating deflector of a micro-column electron beam apparatus in accordance with the present invention will be described below.

Referring to Fig. 5A, a hole **12** with 2mm to 3mm caliber is formed at the center of the rectangular isolation substrate **11** made of ceramic alumina with 500 μm in thickness.

Referring to Fig. 5B, polymer **13** in kneading condition is buried to the hole **12** and hardened, and the polymer **13** on both surfaces of the isolation substrate **11** is polished so that those surfaces are planarized.

Referring to Fig. 5C, seed metal layers **14a** and **14b** are vacuum deposited on both surfaces of the isolation substrate **11**.

Referring to Fig. 5D, photoresist films **15a** and **15b** are formed on each of seed metal layers **14a** and **14b**. The photoresist films **15a** and **15b** are

formed by coating or laminating of the photoresist materials.

Referring to Fig. 5E, the photoresist films **15a** and **15b** are patterned through exposing and developing processes using mask **60** formed with deflecting plate pattern **61**, pad pattern **62**, and wiring pattern **63** as shown in Fig. 6, and some of the seed metal layers **14a** and **14b** are exposed to form the deflecting plate, pad and wiring.

Referring to Fig. 5F, metal layers **16a** and **16b** with 2μm to 35μm in thickness are formed on exposed portion of the seed metal layers **14a** and **14b** by a plating process. The metal layers **16a** and **16b** corresponding to the pad pattern **62** and wiring pattern **63** are used to the wiring **5** and the pad **6** shown in Fig. 1. At this time, heights of the metal layers **16a** and **16b** should be the same as those of the photoresist films **15a** and **15b**, and the metal used for the plating is beryllium, phosphor bronze, bronze, cupro-nickel, stainless steel, nickel, etc.

Referring to Fig. 5G, polymer layers **17a** and **17b** with 200μm to 500μm in thickness are formed on all surfaces of the isolation substrate **11** by a laminating process. The thickness of the polymer layers **17a** and **17b** are adjusted in consideration of the thickness of the deflecting plate.

Referring to Fig. 5H, the polymer layers **17a** and **17b** are patterned through photography and etching processes using mask **70** formed with deflecting pattern **71** as shown in Fig. 7, and some portions of the metal layers **16a** and **16b** is exposed to form the deflecting plates. The etching process for patterning the polymer layers **17a** and **17b** is performed with Deep RIE (Reactive Ion etch).

Referring to Fig. 5I, metal layers **18a** and **18b** with 200μm to 500μm in

thickness are formed on exposed portion of the metal layers **16a** and **16b** by a plating process. The deflecting plates **3** as shown in Fig. 1 are completed by stacked metal layers **16a** and **16b** and metal layers **18a** and **18b**. At this time, heights of the metal layers **18a** and **18b** should be the same as those of the polymer layers **17a** and **17b** to have a required thickness of the deflecting plate, and the metal used for the plating is beryllium, phosphor bronze, bronze, cupro-nickel, stainless steel, nickel, etc.

Referring to Fig. 5J, the polymer layers **17a** and **17b** and the photoresist films **15a** and **15b** are removed by using solvent.

Referring to Fig. 5K, exposed portion of the seed metal layers **14a** and **14b** are removed.

Referring to Fig. 5L, a hole **19** is formed through which the electron beams pass by oxidizing polymers **13** to be removed at about 500 ° C buried in the hole **12** of the isolation substrate **11**.

Referring to Fig. 5M, metal (Au; **22a** and **22b**) is plated on exposed surfaces of upper and lower deflecting plates **20a** and **20b** stacked with metal layers **16a** and **16b** and metal layers **18a** and **18b**, upper and lower wirings and pads **21a** and **21b** consisted of seed metal layers **14a** and **14b** and metal layers **16a** and **16b**. The metal is plated in thickness of 0.1μm to 0.5μm.

A deflector having eight deflecting plates respectively formed on the upper and lower sides of the substrate has been described in the present invention, however, the deflector having deflecting plates formed only at the upper or lower side of the substrate can also be fabricated.

As mentioned above, the present invention exposes some portion of the

seed metal layers in which deflecting plates, wirings, and pads are to be formed by photolithography process using a predetermined mask, after forming seed metal layers on both surfaces of a substrate. Wirings and pads are formed by plating metal on the exposed portion, and some portion in which the deflecting plates are to be formed by lithography process using a predetermined mask is exposed, and then the deflecting plates are formed by plating metal with required thickness.

Since plurality of deflecting plates are formed on both sides of the substrate through metal plating at the same time, alignment between those deflecting plates and corresponding relation between those deflecting plates on upper and lower part of the substrate is made exact, and productivity and reproducibility is improved by fabricating the deflector integrated with the substrate and deflecting plates.

Furthermore, since the deflecting plates, wirings and pads are directly formed on the substrate, structural safety is improved and thereby durability is also improved.

In addition, the present invention forms the polymer layers used as a mask layer by laminating process when performing metal plating, the polymers can be easily formed and removed, shape (rectangular degree) and size of side wall of the deflecting plate can be exactly controlled, and alumina substrate having high intensity is used for the substrate, and the deflector is fabricated by metal plating process, so that stacking and packaging is facilitated and multi layered deflectors can be fabricated.

Although the present invention has been described in conjunction with

the preferred embodiment, the present invention is not limited to the embodiments, and it will be apparent to those skilled in the art that the present invention can be modified in variation within the scope of the invention.